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## The Comparison of Combined Vacuum Microwave Method with Hot Air Method for Drying of Loquat

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### ABSTRACT

Loquat (*Eriobotrya japonica* Lindl.) is a subtropical evergreen fruit tree, native to the southeast of China, belonging to the Maloideae subfamily of the Rosaceae. Because of the short harvest season and the sensitivity to storage even at refrigerated conditions, most fresh loquat should be preserved in some form. Drying is among the commonly used preservation methods. The quality of dehydrated products is dominated by drying methods and conditions. In this study the effect of the combination of microwave and vacuum drying on the quality of Loquat was compared to conventionally dried products. Microwave and vacuum drying method (Microwave power =300, 450 and 600 W and vacuum pressure =0, 25 and 50 Kpa) In comparison with hot air method (temperature=70°C) were studied for their effects on EC50, ΔE, Texture, porpsity and density. The results showed the samples that dried under microwave and vacuum drying method have higher quality and their color an appearance are closer to fresh fruit.

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## INTRODUCTION

Loquat (*Eriobotrya japonica* Lindl) is a subtropical evergreen fruit tree, native to the southeast of China, belonging to the Maloideae subfamily of the Rosaceae. Loquat is cultivated in Cyprus, Egypt, Greece, Israel, Italy, Spain, Tunisia and Turkey. It is also widely distributed in many European, Asian, and American countries (Gisbert *et al.* (2009); Martinez-Calvo *et al.* (1999). According to the 2003 data, Turkey has some 288,000 loquat trees and these yield 13,000 tones of fruit (Sutcu and Demiral (2009). Loquat fruit are round or oval in shape weighing about 20 to 80 g and grow in loose clusters. The fruit has a smooth or downy, yellow or orange, sometimes red-blushed skin. Ripe fruit flesh is soft and juicy with a mild, sub-acid and sweet flavor, varying in color from white to deep orange or salmon (Shaw 1980). It contains nearly all the essential nutrients including proteins, minerals and carotenoids .Fruit flavor is closely related to the ratio between sugar and acid taste. The fruits have various tissues, namely epidermis or epicarp, flesh or mesocarp (edible portion of the fruit), integument (very thin layer covering the seed), one to four seeds in each fruit and a hairy receptacle. In terms of weight, the seeds comprise about 20–30% of the weight of the whole fruit (Femeniaa *et al*, 1998 and Freihativ *et al* , 2008). Because of the short harvest season and the sensitivity to storage even at refrigerated conditions, most fresh loquat should be preserved in some form. Drying is among the commonly used preservation methods .The quality of dehydrated products is dominated by drying methods and conditions. Due to difficulties of hot air drying, a rapid, safe and controllable drying operation is required. Microwave–assisted vacuum drying is a rapid and efficient dehydration method that can yield unique characteristics and improved quality compared to conventionally dried products. (Scaman and Durance 2005).In this study the effect of the combination of microwave and vacuum drying on the quality of Loquat was compared to conventionally dried products.

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*Methodology:**Sample Preparation:*

The loquats were purchased from a local market (Tonekabon, Iran). They were sorted visually for maturity and size, were washed with tap water and surface dried with a filter paper. To increase permeability of skin loquats, they were dipped in NaOH (0.5 Molar) for 2 minutes (samples were washed after dripping to avoid any NaOH residual). The average initial moisture content was 85% in wet basis, gravimetrically measured using an oven at 105°C for 18 hour (time required to stabilize its weight (Deng and Zhao (2008)), and a target moisture content equal to 20%.

*Microwave-assisted vacuum drying:*

Drying was carried out by a combination of vacuum-microwave techniques. Different microwave power intensities (300, 450 and 600 W ) and vacuum pressure (0, 25 and 50 KPa) were studied. One glass containing the samples was placed at the center of oven turntable in microwave cavity during treatment for uniform absorption of microwave energy. The turntable was necessary to achieve the optimum oven performance and to reduce the levels of reflected microwave onto the magnetron (Khraisheh *et al.* (1997).

*Hot-Air Drying:*

Loquats were dried in a pilot plant hot-air drier (tray dryer, Arm-field, Hampshire, England). The drying was operated at an air velocity of 1.5 m/s parallel to the drying surface of the slices at 75°C dry bulb temperature. The operation mode was controlled using a computer connected to the dryer. To obtain the drying curves, moisture loss was recorded with a digital balance (Cobos, Homburg, Germany) at 5-min intervals beginning 30 min after the start of drying until 30 min before end of drying, after which point it was measured every 10 min. Hot-air drying was conducted until moisture content of 0.2 kg/kg dry matter was reached.

*Analytical methods:**Bulk density:*

The weight of samples was taken with an analytical balance  $\pm 0.01$  gr . The volume of the samples  $V_b$  was determined by the water displacement method. Bulk density ( $\rho_b$ ) was calculated as:

$$\rho_b = \frac{m}{V_b}$$

*True density:*

Samples were powdered and de-aerated to eliminate pores and air, then volume ( $V_t$ ) was measured. True density of samples was calculated as:

$$\rho_t = \frac{m}{V_t}$$

*Porosity:*

Porosity ( $\varepsilon$ ) is obtained by following equation:

$$\varepsilon = 1 - \frac{\rho_b}{\rho_t}$$

*Texture:*

In order to evaluate the texture of the samples, the firmness of dried loquat was determined by a texture analyzer (Hounsfield-H5KS, Haslemere, and Surrey, U.K.). The maximum incurred force was considered as firmness of the sample tissue. The tests were conducted with a load cell (50 N) and the rate of crosshead was adjusted to 50 mm per minute (Moreira *et al.* 2008).

*Antioxidant Activity:*

2.5 mg of DPPH (2, 2-diphenyl-1-picrylhydrazyl) which was purchased from Fluka (Buchs, Switzerland) was dissolved in 100 ml methanol ( $\approx 0.0625$  m mol L<sup>-1</sup>). This stock solution was prepared daily and kept in the dark at ambient temperature. EC50 was determined according to the method of Cam, Hisil, & Durmaz, 2009. 0.1 mL of appropriately diluted loquat extract. The sample was mixed with 3.9 mL of the abovementioned solution. The control sample was prepared with the same volume of methanol. Absorbance at 515 nm was measured at different time intervals using a UV-vis. spectrophotometer (Cecil CE 2502, Cecil Ins., England) until the reaction reached a steady-state condition. The DPPH' concentration in the reaction medium was calculated using a calibration curve. The amount of remained DPPH (%) at the steady state condition was calculated as follows:

$$\%DPPHRem = \frac{[DPPH]_t}{[DPPH]_{of\ control\ sample}}$$

where  $[DPPH]_i$  of control sample and  $[DPPH]_t$  are the initial concentration of DPPH' and the DPPH' concentration at the steady-state condition, respectively. The amount of remaining DPPH' at steady state was plotted against the sample concentration to obtain the EC50 value, which is defined as the amount of sample necessary to decrease the initial DPPH concentration by 50%. EC50 was expressed as mL sample to g DPPH (Cam *et al.*, 2009).

#### Color Measurements:

The color characteristics were used as quality parameter of dried loquat. Color measurement was done using image analysis system. Data were stored in  $L^*a^*b^*$  and RGB color models and color changes during this period were evaluated. The total color difference in  $L^*a^*b^*$  color model was calculated as follows

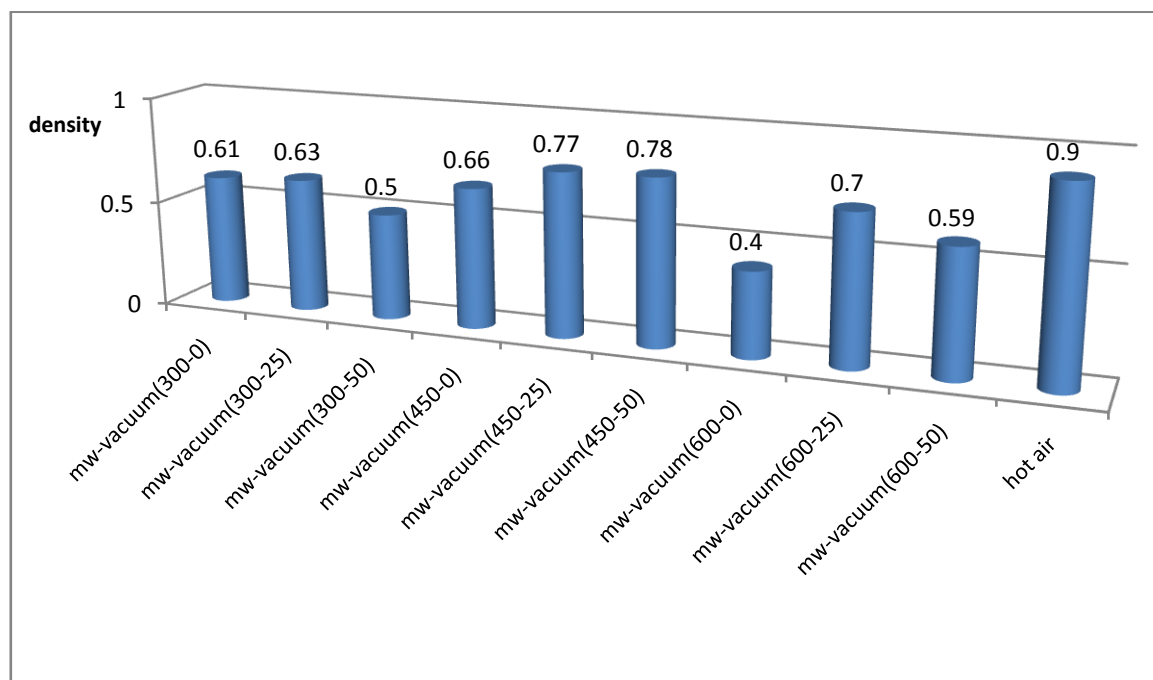
$$\Delta E = \sqrt{(L^* - L_0^*)^2 + (a^* - a_0^*)^2 + (b^* - b_0^*)^2}$$

Parameter  $L^*$  refers to the lightness of the samples, and ranges from black ( $L = 0$ ) to white ( $L = 100$ ). A negative value of parameter  $a^*$  indicates green, while a positive one indicates red–purple color. Positive value of parameter  $b^*$  indicates yellow while negative value indicates blue color. Experiments were replicated ten times.

#### Results:

##### The effects of drying method on samples density:

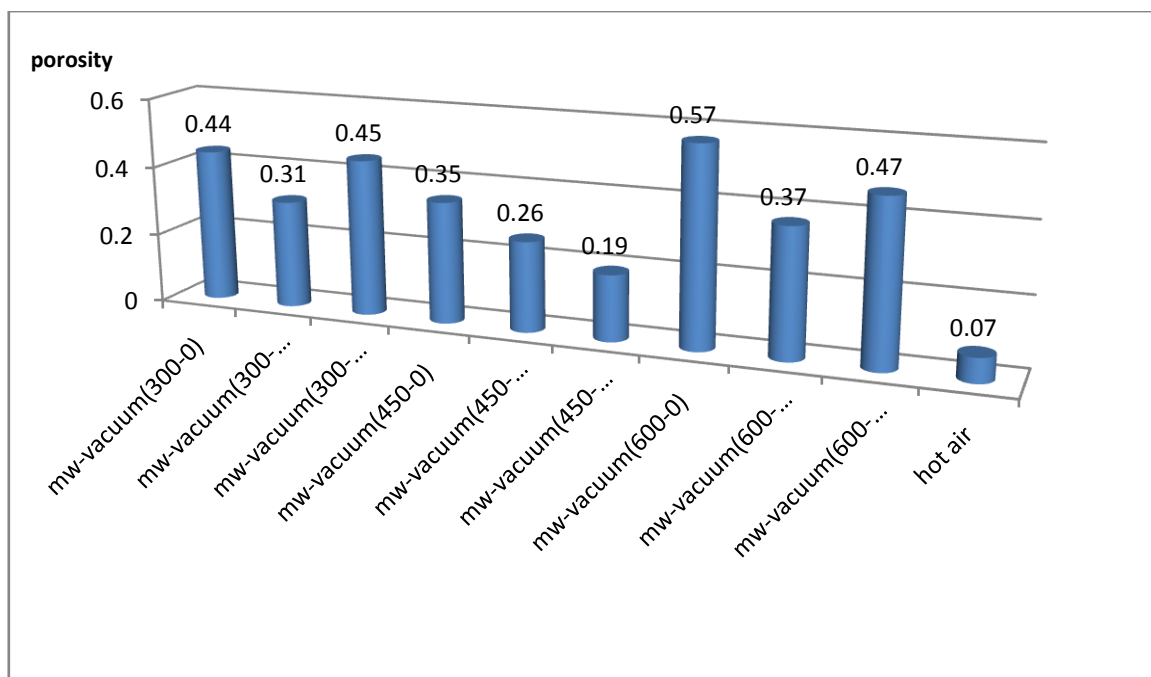
Samples' densities in combination method were in lower amounts in comparison with hot air method implies the preference of former method (Fig 1).



**Fig. 1:** Density results of hot air method and vacuum microwave treatments

##### The comparison of two methods in their effects on samples porosity:

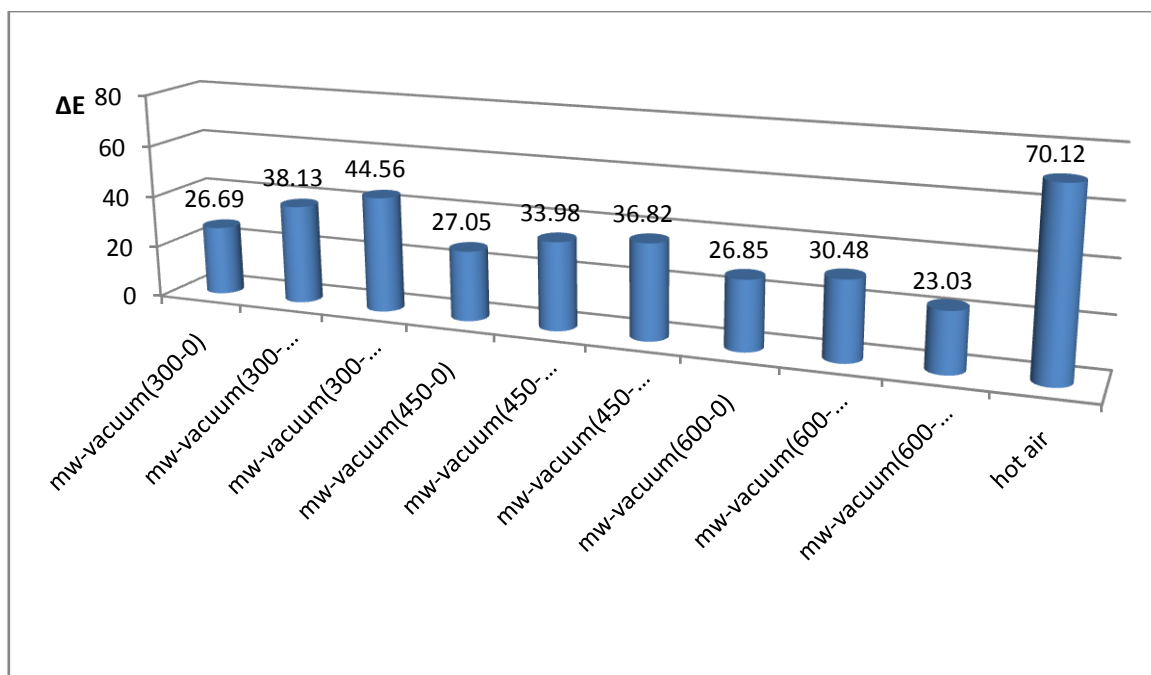
Results revealed a better porosity of samples dried by combination method \*microwave- vacuum method) than hot air methods (Fig 2).



**Fig. 2:** Porosity results of hot air method and vacuum microwave treatments

*The effects of drying method on samples color:*

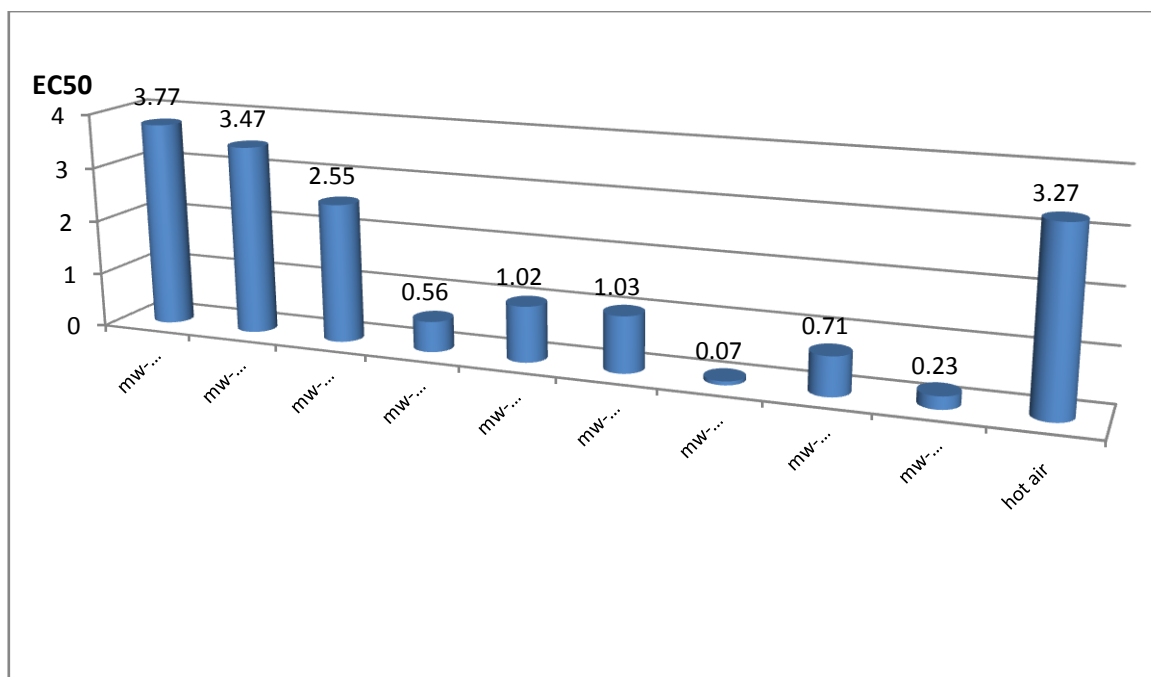
As it shown in figure 3, samples dried by combination method having a better color quality close to primary sample base on  $\Delta E$  amounts.



**Fig. 3:**  $\Delta E$  results of hot air method and vacuum microwave treatments

*The effects of drying method on samples Antioxidant activity:*

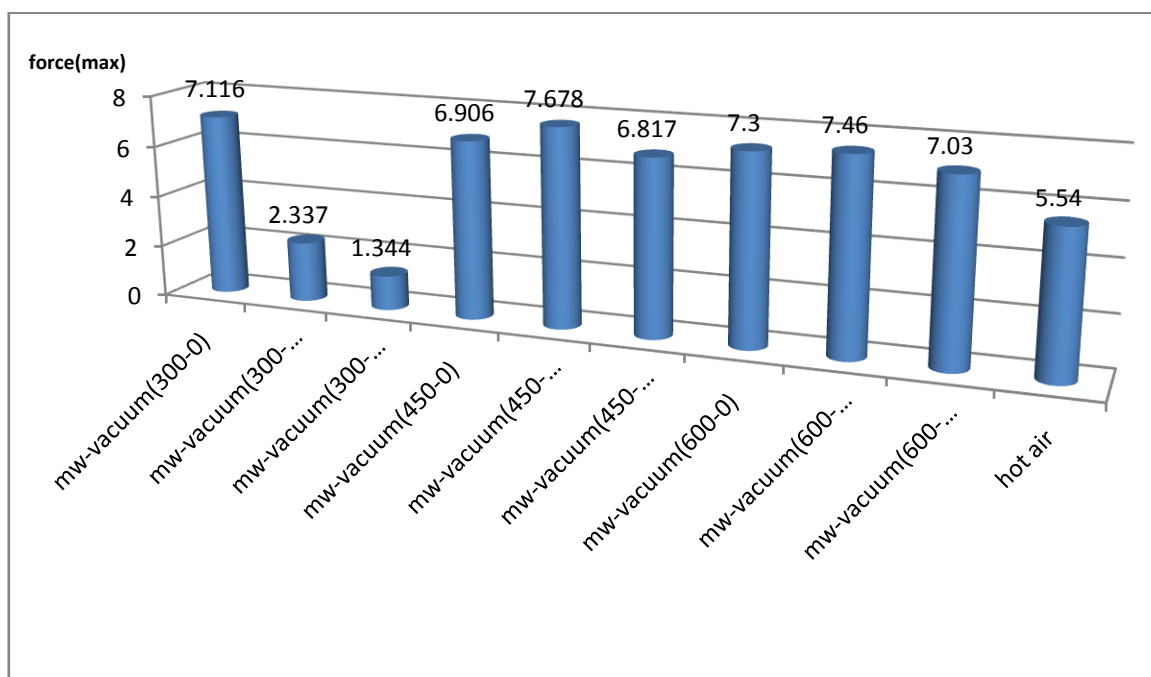
Results also displayed more amounts of samples dried by hot air method in order to reduce DPPH concentration to 50 % of its initial concentration in comparison with combined method, however only more amount required in samples treated by 2 different combination of vacuum and microwave conditions including 0,300 and 25,300 respectively implies more antioxidant activity on sampled dried by combination methods except two later conditions Fig 4).



**Fig. 4:** EC50 results of hot air method and vacuum microwave treatments

*The effects of drying method on samples texture:*

Required force of penetrating probe inside of hot air dried samples were less than combination method except in 2 conditions of microwave power and vacuum amounts including 300, 25 and 300, 50 respectively(combined methods) whose required force were less than hot air method (Fig 5).



**Fig. 4:** Max required force results of hot air method and vacuum microwave treatments

*Conclusion:*

Base on results, density and  $\Delta E$  of samples dried by microwave-vacuum method showed less amounts than hot air method, while porosity was more in combined method ,additionally results displayed more antioxidant activity in combined method except treatment including vacuum and microwave power 0, 300 and 25, 300 respectively, than hot air method, besides more maximum required force to penetrate probe inside of samples

dried by proposed method except conditions in which microwave power and vacuum amounts including 300,25 and 300,50 respectively ,than samples dried by hot air method ,thus samples dried by proposed method (i.e. combination method of vacuum and microwave) exhibits better quality, color and appearance close to natural and fresh fruit.

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